1,025,448

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,025,448

Date of Application and filing Complete Specification: March 12, 1963.
No. 9780/63.
Application made in United States of America (No. 178,980) on March 12, 1962.
Complete Specification Published: April 6, 1966.

Index at acceptance:—H1 T(1A, 7A3, 7A5, 7C3, 7C4, 8, 12); F2 G(4A2, 4A5, 14A1)
Int. Cl.:—H 01 f 23/00 // F 06 d, l

COMPLETE SPECIFICATION

Inductive Signal Transfer Device

We, ROBERTSHAW CONTROLS COMPANY, formerly known as Robertshaw-Fulton Controls Company, a corporation organized and existing under the laws of the State of Delaware, United States of America, of 1701 Byrd Avenue, Richmond, Commonwealth of Virginia, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to inductive signal transfer devices and more particularly to their use in combination with an oxygen supply connection to a mask or helmet in a unitary quick disconnect arrangement which avoids the use of metal to metal contacts.

Astronauts and pilots of military aircraft in the upper atmosphere require a helmet or mask for the control of the oxygen or air supply to the pilot and, at the same time, require connections which can be quickly made or broken in the event it becomes necessary for the pilot to be quickly separated from the craft. Similarly, a diver may require a helmet with an oxygen supply and a communication system associated therewith which may be broken away from the helmet by a single unitary quick disconnect device capable of instantaneous action. It has previously been known to combine with a quick disconnect arrangement for an air supply, a plurality of electrical plugs and sockets each making connection with one circuit in a helmet and with an external circuit. An example of a combined quick disconnect oxygen supply with electrical interconnections between the helmet and external circuitry employing standard jacks and receptacles as illustrated in U.S. patent No. 2,634,311. A disadvantage has been found to result in such a structure from the exposed position of the metal contacts which are subject to surface leakage under conditions of moisture condensation, salt spray and immersion. Under vibration the relatively heavy structure of the components on which the plug and jack are mounted may cause intermittent contact between the plug and jack with the result that communication between the pilot and the remainder of the system is interrupted or is given false or misleading signals. The rather large size of such a structure is also a disadvantage.

It has also been proposed that detachable connections be made between a power supply and another circuit by way of an inductive coupling as in the case of U.S. Patent No. 2,483,815. This patent employs a transformer primary and secondary, one concentric within the other in which it is possible to connect the part of but one circuit. Such signal inductive transfer devices have not heretofor been applicable to the use of several independent circuits combined within a single plug-in member because of the cross talk which would arise.

According to the present invention, there is provided an inductive electrical plug and socket connector comprising a plurality of closed loop transformer cores, each of which is split into two halves, the two halves being mounted in the plug and socket parts of the connector respectively with their ends adjacent surfaces of these parts in an arrangement such that, when the parts are mated, ends of each core half are opposite and adjacent the ends respectively of the corresponding other core half, the halves of each core bearing respective windings which are coupled inductively when the connector parts are mated.

Various arrangements will be described, showing that with such cores it is possible to avoid cross-talk between the two or more circuits. The connector according to the invention is well suited for inclusion of a hose connector for use for example in a pilot's helmet requiring an oxygen supply and electrical connections.

The invention will be described in more

detail with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view of a quick disconnect oxygen supply hose connection combined with inductively coupled electrical connections for the pilot's communication system.

Fig. 2 is a schematic diagram of a portion of a plug and receptacle of Fig. 1 illustrating in detail the circuit connection between ear phones, microphones and external circuits, and

Fig. 3 illustrates an alternative form of a signal transfer device for a plurality of circuits, employing a plug and receptacle suitable for headwear use in which cross talk between circuits is avoided by a further arrangement of the respective cores of the signal transfer devices.

Referring now more particularly to Fig. 1 there is illustrated at 10 an oxygen supply hose connected to a supply (not shown) such as might be contained in the aircraft in which the pilot is operating. An oxygen outlet to the mask or helmet of the pilot is indicated at 11 as a tubular portion of the receiver portion of the quick disconnect fixture. The hose member 10 preferably terminates in a plug member 12 which may be of rectangular form having plane surfaces at the upper and lower sides thereof as viewed in Fig. 1, suitable for close fitting insertion in a receiver 13 to which the hose member 10 is to be connected by way of the plug member 12, thereby to provide a continuous oxygen supply from 10 to 11. Details of such a quick disconnect feature in the oxygen supply for a helmet are disclosed in British Patent Specification No. 959,432. Since these features do not form a part of the present invention they will not further be described here dexcept to note that an arrangement is provided which connects the two hose portions in airtight relationship to withstand the pressure of the oxygen system and at the same time to provide means for instantaneously disconnecting the plug and receiver members.

The arrangement described in specification No. 959,432 employs metal to metal contacts in the faces of the plug member 12 and the receiver member 13 adjacent thereto. According to the present invention an arrangement is provided for replacing the metal to metal contacts with inductive signal transfer arrangements employing transformer core halves 14 and 15, disposed one in the plug member and the other in the receiver member immediately adjacent thereto when the plug member is seated within the receiver member. At the opposite face of the plug member 12 is disposed a transformer core half 16 and immediately adjacent thereto is the complementary member 17 in the receiver member, each such core member being wholly within the member and so positioned that when the quick disconnect device is assembled the magnetic circuit between core members 14 and 15 and between members 16 and 17 is substantially closed. Leads 18—18 and 19—19 correspond each to a circuit extending into the plug member and connecting with opposite terminals of windings 21 and 22 on the corresponding primary core members 14 or 16.

In order that the signal transfer apparatus thus far described shall be completely free of atmospheric shorting or corrosion it is preferable that the assembled core and winding shall be embedded or potted in a plastic block as at 23 and 24, preferably formed by casting. One core and winding may be placed in the plug pocket 25 and another in receptacle pocket 26 in a position to leave each of the core ends 27 lying immediately beneath the surface as the block is cast thereover. It will be understood that such a construction permits the finishing of the surface above the core ends 27 as may be required to cause a proper fit between the plug member 12 and the receiver member 13.

As more fully disclosed in specification No. 959,432 the plug member is engaged within the receiver member and firmly held in that position by means of a retaining hook on the receiver member as at 28 and a retaining bail 29 attached to the plug member. When the bail is passed over the hook and the plug 12 is pressed into the receiver member 13 it may be locked into position by a lever 30 to establish the airtight connection desired and, at the same time, hold corresponding core ends 27 in position adjacent each other, separated only by a thin section of the plastic block respectively surrounding each such core member.

In Fig. 2 there are shown portions of members 12 and 13 in section, respectively, with core members 14, 16, 15 and 17 in position to substantially complete magnetic circuits therebetween to permit signal transfer by induction. Winding 21 is connected to ear phones 21 by way of the leads 32 and winding 21^1 is connected to an external circuit by way of the leads 18. Similarly the winding 22 is connected to a microphone 33 by way of leads 34 and winding 22^1 is connected to the external circuitry by way of leads 19.

For some purposes it may be desirable to have a third communications circuit to the helmet of the aviator. A second microphone may be connected to a further receiver core 35 and thence to a corresponding core 36 on the plug. Winding 37 on the core 35 extends to microphone 38 and corresponding leads and winding on the core 36 extends to circuitry within the airplane.

Such a third signal transfer device might be used, for example, with a second microphone or other device as at 38, which might connect to a second signal output from the pilot, going by internal craft connections to a copilot. The microphone 33 might be of the dynamic type in which a sound powered diaphragm and signal generator furnishes current

inductively coupling windings 22 and 22¹ thence extending to the aircraft communication system by means of leads 19. Either microphone 38 or 33 might be of the carbon button type or of any other construction employing a small battery to provide a current which is modulated by the action of the microphone in order to provide a more adequate signal to be coupled to the external communication system.

Since two magnetic circuits in closely spaced relation have a tendency to interact under conditions of varying excitation, as in communications, precautions are required to minimize the flux linkage from one transfer core to another. Considering the plug member 12 the contained cores 14 and 16 are oppositely disposed to minimize flux therebetween both by separation of pole pieces 27 and by orientation. In a third closely spaced transformer the cores 35 and 36 may be disposed at right angles to the cores 14 and 15, or to 16 and 17 such that any leakage flux is at right angles rather than parallel to the core structure which might otherwise gather a portion thereof to induce cross coupled signals.

Such an embodiment of the invention as has previously been described is particularly adapted for use with a helmet-mounted oxygen supply connection of the quick disconnect type, but is not so limited in its application. This arrangement may be employed in a diver's helmet, a bathysphere, or any other similar arrangement in which it is necessary to pass signals through an outer wall into an inner container without the use of metal to metal contacts such as could be shorted by immersion in water or by atmospheric moisture conditions.

One arrangement might include a diver's or radiation monitor's helmet to which a connection must be made after the helmet is placed on the wearer's head but which is quickly removable for washdown or in order to give mobility to the wearer, yet making possible the interconnection of the circuitry to and from his communication system without the use of exposed contacts of any type. A cable 41 (Fig. 3) for this purpose might include a number of signal leads all enclosed within a waterproof rubber or plastic covering which connects to a plug member 42 by means of a fairlead arrangement 43 protecting the cable against chafing or breaking at the connection point.

Plug member 42 in this version may be of cylindrical form in which corresponding core halves as at 14 and 16 of Fig. 2 are employed each with its winding thereon connecting to the leads within the cable 41. Such core members are disposed within the plug member in a position to exactly match the position of the corresponding core halves 15 and 17 disposed within the outer walls or lateral projections of the receiver and socket member 48, generally in the manner illustrated in Fig. 2, except that orientation is now required between the cylindrical plug and receptacle members so that the corresponding core halves will be oppositely disposed for maximum transfer of signal.

Such a connector may also conveniently employ a third core 44 like core 35 but disposed in the end of the plug member to cooperate with a similar core 44¹ in the end of the socket member for the transfer of a third set of signals.

Placing the plane of cores 35 and 36 in Fig. 1 at right angles to nearby cores 14 and 15 has been described as a necessary measure to minimize cross talk between circuits. In the arrangement shown in Fig. 3 the break the magnetic circuit for core 44 is at right angles to the plane of the break for the core 14 or 16, and leakage flux paths of the respective cores are at right angles thereby to prevent any substantial degree of flux linkage between the third and the first or second transfer devices.

The plug member 42 is preferably supplied with a key portion 46 along one face thereof which fits within a slot 47 in the corresponding face of the receptacle member 48 such that when the two are placed in key-oriented operative position this position is maintained with certainty and exactitude. The socket member is preferably attached to a helmet or enclosure wall at 49 by means of attached nipple 51, collar 52 and nut 53. Internal connections pass from the socket member through a hole 54 in wall 49 to leave an airtight enclosure through which signals pass without use of exposed metal electrical inserts or contacts.

It is desirable to maintain a close friction fit between the plug and socket members of Fig. 3, but not to rely exclusively upon friction to prevent relative axial motion. Spring clips 55 and 56 are appropriately secured to the socket member along two or more oppposed sides thereof by means of retaining ring 57 and/or slots according to the method of manufacture most convenient. Clips 55 and 56 have turned in portions 58 arranged to overlie the outer end of the plug member when in place and retain it in that position, and have sloped portions 59 adapted to ride over the plug as it is inserted.

WHAT WE CLAIM IS:—

1. An inductive electrical plug and socket connector comprising a plurality of closed loop transformer cores, each of which is split into two halves, the two halves being mounted in the plug and socket parts of the connector respectively with their ends adjacent surfaces of these parts in an arrangement such that, when the parts are mated, the ends of each core half are opposite and adjacent the ends respectively of the corresponding other core half, the halves of each core bearing respective

windings which are coupled inductively when the connector parts are mated.

2. A connector according to claim 1, wherein there are at least two cores with are coplanar but spaced from one another in a direction which is perpendicular to two planes along which the cores are respectively divided into two halves.

3. A connector according to claim 1 or 2, wherein there are at least two cores which are disposed in perpendicular planes.

4. A connector according to claim 3, wherein the said cores disposed in perpendicular planes are divided into two halves along a common plane.

5. A connector according to claim 1 or 2, wherein there are at least two cores which are coplanar but divided into two halves along two respective perpendicular planes.

6. A connector according to claim 2, wherein the halves of the said two cores mounted in the plug part are disposed on opposite sides of the plug part adjacent side walls thereof.

7. A connector according to claim 3, wherein the said two cores disposed in perpendicular planes have their halves which are mounted in the plug part adjacent the same side wall of the plug part.

8. A connector according to claim 5, wherein the said two cores divided into two halves along perpendicular planes have their halves which are mounted in the plug part adjacent a side wall and a transverse wall respectively of the plug part.

9. A connector according to any of the preceding claims, wherein the core halves and windings thereon are embedded in a synthetic resin.

10. A connector according to any of the preceding claims, wherein the two parts of the connector also include the two parts of a hose coupling.

11. A pilot's or other helmet having a connector according to any of the preceding claims.

12. An inductive electrical plug and socket connector substantially as hereinbefore described with reference to and as illustrated in Fig. 1 of the accompanying drawings.

13. An inductive electrical plug and socket connector substantially as hereinbefore described with reference to and as illustrated in Fig. 2 of the accompanying drawings.

14. An inductive electrical plug and socket connector substantially as hereinbefore described with reference to and as illustrated in Fig. 3 of the accompanying drawings.

REDDIE & GROSE,
Agents for the Applicants,
6, Bream's Buildings, London, E.C.4.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1966. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

1025448 COMPLETE SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG.1

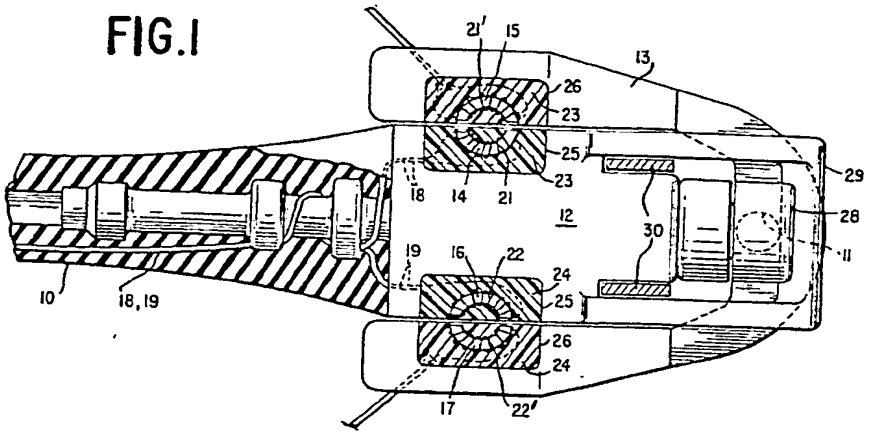

FIG.2

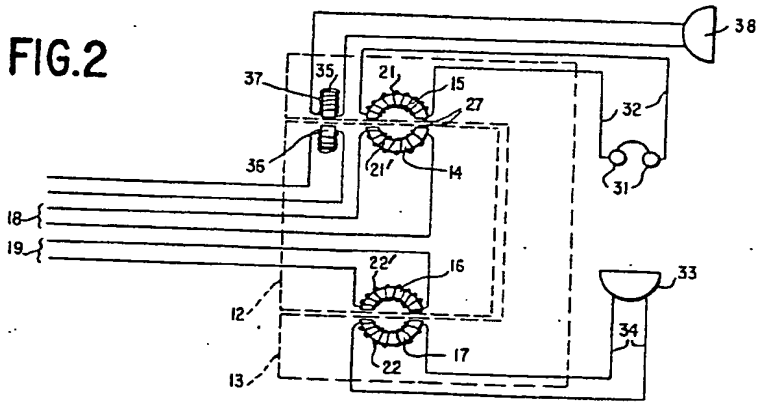

FIG.3